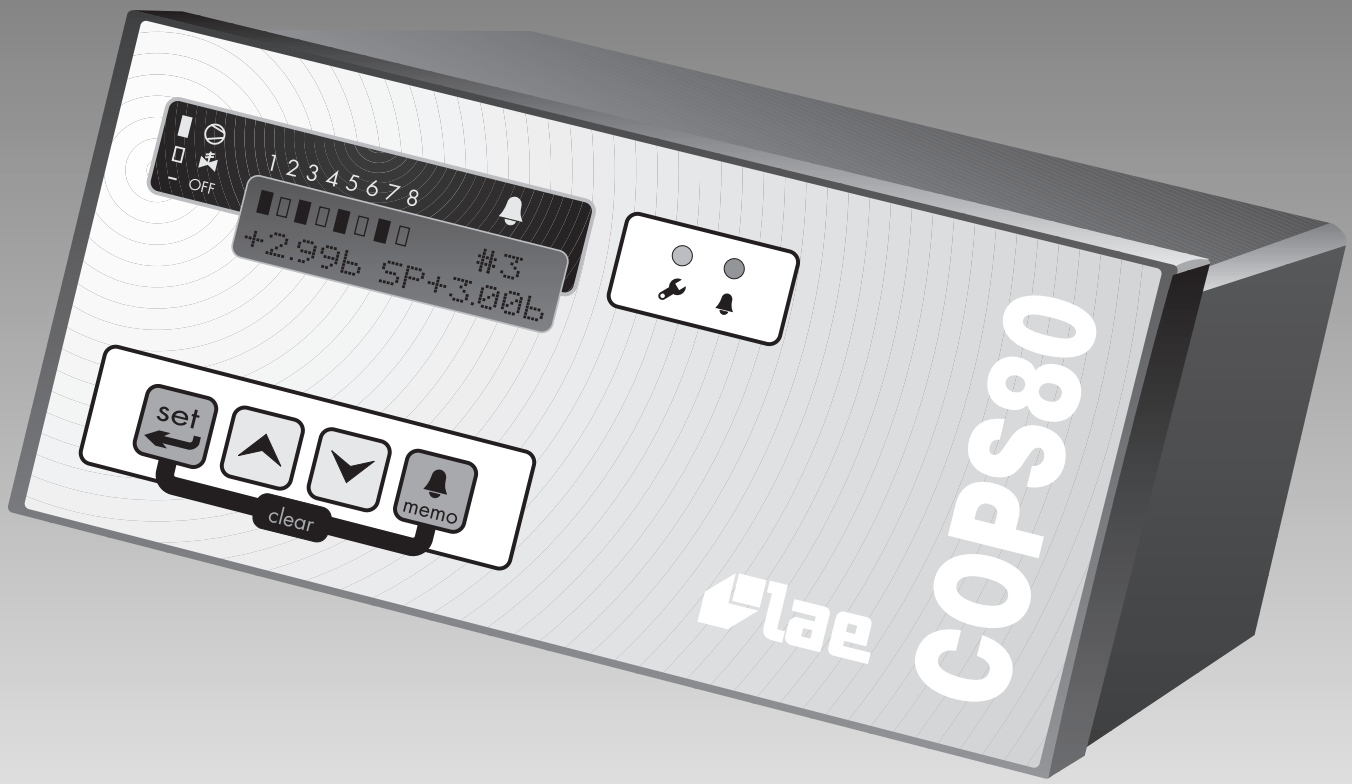
COPS 80

Instructions for installation and use



Before proceeding to the installation of the COPS 80, we recommend you to read this instruction booklet carefully and entirely. Only in this way you will obtain maximum performance and reliability.
The **COPS 80** controls the suction pressure on multi-compressor packs for variable demand cryogenic plants. Through sophisticated algorithms the COPS 80 can control up to eight outputs to drive single or multiple stage compressors and monitor the correct function of the whole plant on real time. The main unit is connected by means of ribbon cable to one or two COPM 28 modules in which are the outputs and their diagnostics.

1 INSTALLATION

1.1 Secure the COPS 80 main unit through its snap-on system to a 0.7...1.5mm thickness panel, with 182x81 mm cutout. Carefully check that there is no gap between the rubber gasket and the panel.

1.2 Secure the COPM 28 control modules to the DIN-rail, as close as possible to the main unit.

1.3 For a correct function, the system must operate at an ambient temperature between -10°...+50°C and 15%.. 80% relative humidity.
To reduce the effects of electro-magnetic disturbances, locate the signal cables (probe, ribbon cables etc.) and the controller as away as possible from contactors and power wires. Do not wrap the excess of cable but "Z" fold it.

1.4 Probe, power supplies and all inputs/outputs of the system must be connected strictly following the indications appearing on the technical sheet (see fig. 2 and 3).

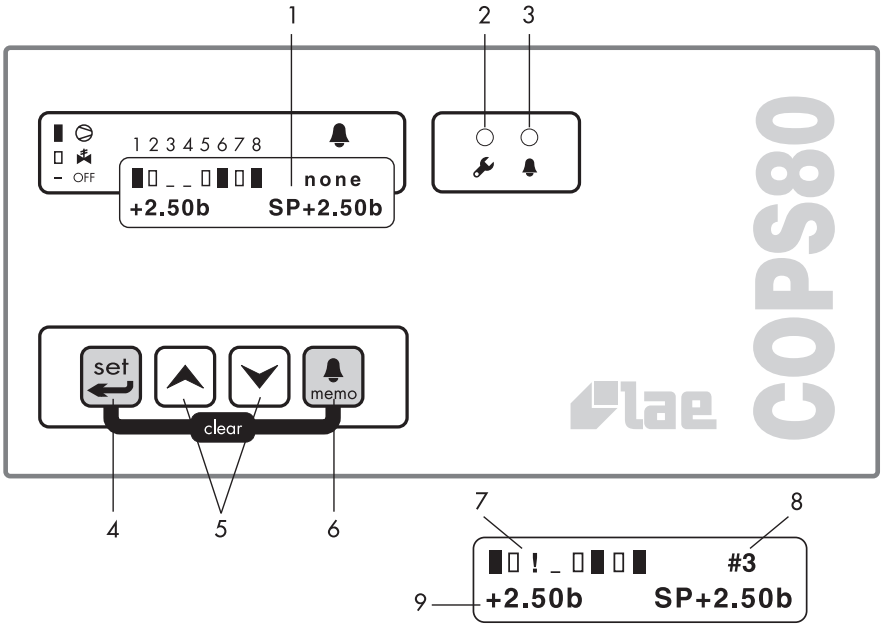


FIGURE 1

1 Backlit LCD display
2 Periodic maintenance LED
3 Current alarm LED
4 Programming access key
5 Increase/decrease keys
6 Key to display stored alarms
7 Output status indicator
8 Alarm status/counter indicator
9 Operating data

CAUTION!: The wiring panel of the COPS 80 is under voltage. Beware of **electrical shocks**; an accidental contact may be fatal to persons or animals.

2 INDICATIONS

The LCD [1] allows to clearly display all possible indications helping to understand number and configuration of the compressors, their present status and the accumulated run time, pressure or temperature of the gas in the suction manifold, possible current or stored alarms.
To facilitate understanding even more, it's possible to select the language (English, German, Spanish, Italian).

2.1 On power-up, the entire display [1] is on for 2 seconds approx., after that the software release appears and finally all display areas take their specific functions.

2.2 In area [7] of the display the enabled outputs, from 1 to 8, and their status appear: ***stand-by***, control output off status for an undefined time; ***nnnn***, time left to the end of the warming-up phase; (-) switched off output; (▮) switched on compressor; (□) switched on stage; (!) output on alarm from diagnostics input.

2.3 If alarms are on, on area [8] their source appears: ***probe***, pressure transmitter fault or overrange; out'N', no feedback from output 'N'; ***rel.HP***, pressure exceeding the high dead zone; ***psw.HP***, HIGH Pressure switch external contact; ***psw.LP***, LOW Pressure switch external contact; ***level***, refrigerant liquid external contact; ***aux.***, auxiliary alarm contact opening.
Area [8], if no alarms are on, shows the number of stored alarms: none, 1,..10.

2.4 In area [9], through keys [5] it's possible to select the data to display: suction GAUGE pressure and setpoint; corresponding temperature and setpoint; totalized run time of the

compressors.

2.5 By pressing and keeping key [6] pressed, the stored alarms are displayed in area [9]; it's possible to scroll this memory backwards and forwards by means of keys [6]+[5] or cancel the displayed location with keys [6]+[4].

2.6 LED [2] illuminates when at least one of the compressors achieves the programmed run hours for the warning to come up.

2.7 LED [3] blinks when an internal or external alarm is detected.

3 PROGRAMMING

The COPS 80 is a controller able to perform complex control functions to the best, it must therefore be able to recognize the plant connected to it without any doubt. To this purpose, before the first system start-up, it is mandatory to program the configuration parameters carefully in order to obtain a perfect adaptation of the COPS 80 control algorithms to the specific plant.

As such parameters have a different influence on the whole function, access to the various settings has been divided into 4 levels. This partition aims to allow access to authorised service technicians only, avoiding in this way dangerous configuration mistakes.

The partition of the parameters, their identification code and the programmable range appear on Table A.

CAUTION: beware that reprogramming some of the parameters implies a total re-configuration of the COPS operating mode, we therefore recommend to put the controller on stand-by in the event that you have to change parameter values of level higher than 1.

3.1 You have got access to programming by keeping key [4] pressed for 2 sec. Now, the display asks for the pass code; set your own code by means of keys [4]+[5]. If the code is 0 or invalid, you have access to level #0 parameters only.

3.2 Through keys [5], achieve the desired parameter, press then [4]+[5] to set the value. All parameters except the pass code are stored in non-volatile memory and resumed on following power-ups.

Exit from programming occurs automatically after 15 sec. of no operation on the keyboard or immediately, by simultaneously pressing both keys [5].

3.3 Parameter function:

1. **pass code**, allows access to the various programming levels.
2. **stand-by**, enables (NO) or switches off (YES) the control and alarm functions.
3. (language), allows to display all inscriptions in the favourite language.
4. **LCD contrast**, suitably adjusts the contrast on display according to viewing angle, ambient light etc.
5. **main SET**, provides the reference suction pressure, becoming the dead zone mid value.
6. **alternative SET**, if enabled and switched on, replaces the main SET temporarily.
7. **dead zone**, adds a pressure gap, above and below the current set, such as to maintain the output status unchanged as long as pressure remains within this band.
8. **relative High Pressure alarm delay**, if the suction pressure remains higher than the upper dead zone for at least this time, a relative high pressure alarm takes place.
9. **compressor cut-in delay**, the suction pressure must be higher than the upper dead zone for this time before the next compressor cuts in.
10. **compressor stop delay**, the suction pressure must be lower than the lower dead zone for this time before the next compressor stops.
11. **minimum compressor stop**, provides the minimum time that must elapse between compressor stop and its next cut-in.
12. **maximum compressor run**, when compressor rotation is enabled this parameter, if greater than 0, establishes the time after which considering the possibility of swapping two compressors.
13. **stage cut-in delay**, the suction pressure must be higher than the upper dead zone for this time before the next stage cuts in.
14. **stage stop delay**, the suction pressure must be lower than the lower dead zone for this time before the next stage stops.
15. **warming-up**, puts a delay between COPS power-up and output on switching in order to allow that the compressor crankcases warm up through their electrical heaters.
16. **down scaling limitation**, imposes the minimum number of outputs that must remain on even during an alarm period with quick down scaling function.
17. **peripheral number**, gives the COPS an address in the event that, through the serial port, the controller must be linked to a data transmission network.
18. **number of compressors**, provides the number of outputs that are connected to compressors. The maximum programmable value depends on parameter 19.
19. **number of stages/compressor**, provides the number of stages for each compressor (equal for all). The maximum programmable value depends on parameter 18.
20. **compressor rotation**, if enabled (YES), applies the optimised management algorithm to minimize the Starts/Stops per hour of each compressor. Differently (NO) the outputs will be switched on and off with fixed sequence, from 1 to 8.
21. **refrigerant**, allows Pressure ⇨Temperature conversion according to the refrigerant media used.
22. **probe offset**, adds a constant correction to the value measured by the pressure transmitter to obtain the value to be processed by the COPS (display, control etc.).
23. **minimum probe current input**, programmed according to the 0...20/4...20 mA transmitter used.

24. **minimum range**, this value must match the minimum transmitter range, i.e. the pressure corresponding to its minimum current (0/4mA).
25. **maximum range**, this value must match the maximum transmitter range, i.e. the pressure corresponding to a 20mA current.
26. **alternative SET input**, if enabled (YES), when providing the required on voltage to the relevant input, it shifts the control reference value, i.e. the dead zone mid value will be parameter 6 instead of 5.
27. ... 34. **output 1 ... 8 diagnostics**, if enabled (YES), carries out a monitoring on the corresponding output to detect an interruption by external causes. Differently (NO) the voltage applied to the feedback inputs will have no effect on the controller operation.
35. **Condenser High Pressure switch input**, if enabled (YES), checks that the relevant input always receives the required on voltage. If this condition is not fulfilled, the COPS considers this as a high pressure alarm on the condenser side. If disabled (NO), this input is not considered.
36. **Suction Low Pressure switch input**, if enabled (YES), checks that the relevant input always receives the required on voltage. If this condition is not fulfilled, the COPS considers this as a low pressure alarm on the suction side. If disabled (NO), this input is not considered.
37. **liquid level input**, if enabled (YES), checks that the relevant input always receives the required on voltage. With par.39 you add a time in which failure continuity is checked; when this time expires, the COPS signals that there's a low refrigerant liquid alarm. If disabled (NO), this input is not considered.
38. **auxiliary alarm input**, if enabled (YES), checks that the relevant input always receives the required on voltage. If this condition is not fulfilled, the COPS signals this as an auxiliary alarm. If disabled (NO), this input is not considered.
39. **liquid level delay**, if the relevant input does not receive the required on voltage for at least this time, then a low liquid alarm takes place.
40. **next maintenance**, provides the amount of run hours of at least one compressor for the maintenance warning to come up (LED [2]).
41. ... 48. **output 1 ... 8 run time**, allows to reset the hour counter for each output so as to permit the programming of a new maintenance cycle.
49. **0 adjust**, allows low range recalibration.
50. **full scale adjust**, allows span recalibration.

4 OPERATION

On every power-up, after self-check (4 sec approx.), the COPS 80 starts to control according to the latest programmed values.

4.1 STAND-BY. With par.**2**=YES the control functions are suspended, the COPS proceeds to progressively switching off all the outputs with fixed 5 sec steps and on area [7] of the display "stand-by" appears.
This status remains even on following power-ups until the control is enabled again (par.**2**=NO).

4.2 WARMING-UP. If par.**15** is greater than zero, ex. 30 min, on power-up all outputs will remain off during the programmed time and on area [7] of the display the seconds left to the end of this phase are shown (1800, 1799, 1798,..).

4.3 PRESSURE CONTROL. During the normal control phases, the COPS acts on the outputs to constantly maintain the suction pressure around the reference value. Such value is given by par.**5** or, if par.**26**=YES and the set selection input receives the required on voltage, by par.**6**.
If the measured pressure stays within the reference value ± the dead zone (par.**7**), the number of switched on outputs will not change. If pressure exceeds par.**5/6** + par.**7**, the on sequence starts, differently, if the pressure drops lower than par.**5/6** – par.**7**, the off sequence starts.

4.4 CUT-IN DELAYS. When a suction pressure increase requires that an output is switched on, before the switching takes place the COPS waits for this condition to constantly remain for a time at least equal to: par.**9** if, according to the control sequence, the next output is a compressor, par.**13** if a stage.

4.5 STOP DELAYS. Before switching off an output because of a suction pressure drop, the COPS waits for this condition to constantly persist for a time at least equal to: par.**10** if, according to the control sequence, the next output is a compressor, par.**14** if a stage.

4.6 CONTROL SEQUENCE. With par.**20**=YES, the compressor to be switched on(off) is identified according to its last run(stop) time lapse, in other words the compressors are sorted by length, from the longest to the shortest. Example, in this situation: C1=ON for 5 min.; C2=OFF for 7 min., C3=OFF for 8 min., C4=ON for 6 min.; the sequence will be ON ⇨C3,C2; OFF ⇨C4,C1.
With par.**20**=NO, the sequence is always the same and follows the output order, ON ⇨C1,C2,C3,C4; OFF ⇨C4,C3,C2,C1.
However, a compressor cuts in if only all running compressors have achieved full power (all stages on).

4.7 CUT-IN LIMITATION. To avoid short cyclings reducing the compressor life, it's possible to limit the starts per hour by setting par.**11** greater than 0. In this case, as long as this rest time has not elapsed, a compressor is excluded from the control sequence. If this happens, on the basis of the selection mode (see 4.6), the COPS 80 gets started the first compressor fulfilling

this criterion.

4.8 FORCED ROTATION. During the normal operation, demand variations cause pressure huntings out of the dead zone, therefore the control algorithm applied with par.**20**=YES induces an automatic swap of the running compressors and, as a final result, a total run time equalization.
If, on the contrary, the pressure remains within the dead zone for a long period, no output variation will take place. A remedy is to enable forced rotation.
By giving par.**12** a value greater than 0, if the COPS finds a running compressor achieving the time lapse programmed (ex. 60 min.) and a stopped compressor fulfilling the swapping criteria (shorter total run time, minimum stop etc.), then it forces rotation process. The controller switches off the compressor to get the designated one running.

4.9 OUTPUT OPTIMIZATION. If two compressors are simultaneously reduced in capacity (one or more stages switched off) as a result of an alarm (output diagnostics, down scaling etc.), the COPS starts the optimization function. It proceeds to a progressive power shift from a compressor to the other, according to the programmed control algorithm.
This optimizes the electrical power consumption without changing the mechanical power.

4.10 POWER SCALING. If alarms with **down scaling** function are detected, the number of switched on outputs is progressively reduced in 5 sec steps, until reaching par.**16**. For example, if the COPS receives a High Pressure signal from the condenser while operating with 6 switched on outputs and par.**16**=3, a progressive quick down scaling of the number of outputs will take place until, in 10 sec, 3 outputs only remain on.
During off switching the programmed control sequence is maintained.
When the COPS operates in down scaling, the number of on outputs may only be further reduced and not increased. In addition, the OPTIMIZATION and FORCED ROTATION functions are suspended.

5. ANOMALIES AND ALARMS

The COPS 80 features a sophisticated abnormal operation condition detection system. When an anomaly is detected, area [8] of the display shows its source (see 2.3) and, as long as the condition persists, the alarm relay contacts will change status and LED [3] blinks. The buzzer goes off simultaneously with the other signallings but it can be muted by pressing any of the keys.
Every alarm event is stored in non-volatile memory, it will not therefore be lost with a power failure. For this function 10 records are available and when they are filled the following alarms will be lost. Therefore we recommend to periodically erase the old alarms from the memory as described in 2.5.
On warming-up and stand-by all alarms are suspended.
In the next paragraphs is a description of the alarm sources, the corresponding indications on area [8] of the display and the possible repercussions on the control logic.

5.1 TRANSMITTER FAULT/OVERRANGE, *"probe"*. Signalled if the pressure transmitter exceeds the range programmed with par.**24** (with 4...20mA exclusively) or par.**25**.

5.2 RELATIVE HIGH PRESSURE ON SUCTION, *"rel.HP"*. Signalled if the suction pressure continuously remains beyond the dead zone upper limit (see 4.3) for a time longer than par.**8**. The alarm ends when pressure goes back within the dead zone.

5.3 HIGH PRESSURE ON CONDENSER SIDE, *"psw.HP"*. Signalled when par.**35**=YES and the relevant input does not receive the required on voltage. This alarm causes output **down scaling** (see 4.10). The alarm ends when the input receives the required on voltage again.
With par.**35**=NO this alarm is inhibited.

5.4 LOW PRESSURE ON SUCTION, *"psw.LP"*. Signalled when par.**36**=YES and the relevant input does not receive the required on voltage. This alarm causes output **down scaling** (see 4.10). The alarm ends when the input receives the required on voltage again.
With par.**36**=NO this alarm is inhibited.

5.5 LOW REFRIGERANT LIQUID, *"level"*. Signalled when par.**37**=YES and the relevant input does not receive the required on voltage for a period longer than par.**39**. The alarm ends when the input receives the required on voltage again.
With par.**37**=NO, this alarm is inhibited.

5.6 AUXILIARY ALARM, *"aux."*. This alarm is available for installers' general purposes. It signals when one or more external alarm events occur, provided that par.**38**=YES and the relevant input does not receive the required on voltage. The alarm ends when the input receives the required on voltage again.
With par.**38**=NO, this alarm is inhibited.

5.7 OUTPUT FAULT, *"out 'N'"*. Usually every large or middle sized motor compressor has got a series of protecting devices aiming at preserving itself from damage arising from winding overheating, phase interruption, lubricant lack etc. By linking all these contacts together, a safety chain is created that opens whenever a critical condition occurs.
The output monitoring has the purpose of detecting contactor coil supply interruption as a result of protection intervention (see figure 3).
The monitoring is enabled by giving YES to the relevant flag (par.**27**...**34**). If the diagnostics is enabled and its feedback input does not receive the required on voltage, the COPS detects the anomaly and reacts in different ways depending on the load connected, compressor or stage.
Compressor anomaly: it signals the alarm condition (*out'N''* and (!) on display; LED [3]; relay etc.) switches off all stages to allow a following soft start; keeps that output on to detect a possible self-recovery.
A compressor in alarm mode is excluded from the on and off switching sequences.

Stage anomaly, in this case the COPS reacts by signalling the alarm condition, and keeps the output switched on looking forward to self-recovery.
Whenever the NC contacts on the COPM 28 are used, you must consider an inverted feedback signalling.

5.8 POWER SUPPLY FAILURE, in this case an alarm signalling occurs through the relay contacts only, no other shining or acoustic signallings take place and this anomaly is not stored in the alarm memory.

6. AUXILIARY FUNCTIONS

In addition to what we described above, the COPS 80 performs other functions with the purpose of facilitating the work of those who have to use it.

6.1 LANGUAGE. In any moment it's possible to change the language on the display by selecting it with par.**3** among those available.

6.2 DISPLAY CONTRAST. Through par.**4** it's possible to change the LCD display contrast. It allows to adjust indication readability to the best according to the operator's viewing angle or ambient light.

6.3 PRESSURE ⇨TEMPERATURE CONVERSION. Parameter **21** allows to select the refrigerant media used in order to correctly convert the setpoint and gauge pressure measured in its equivalent boiling temperature.

6.4 PROBE OFFSET. If the value read by the pressure transmitter does not match the pressure applied to it perfectly, it's possible to proceed to recalibration (see 7.) or add a constant correction value across the whole measuring range through par.**22**.

6.5 MAINTENANCE. If wishing to obtain an automatic periodical maintenance warning, it's possible to act on par.**40**...**48**. For example, if it's necessary to intervene after 5,000 compressor run hours, set par.**40**=5,000. When any of the compressors achieves 5,000 run hours, LED [2] lights up.
Now, after having performed the intervention required, you may enter PROGRAMMING at level #3 and clear the hour counters (par.**41**...**48**) to repeat the cycle or shift par.**40** to the next warning (ex. par.**40**=10,000).
Warning: the counters have a maximum capacity of 32,000 hours and are used to accumulate the run hours and for the FORCED ROTATION. It's therefore necessary to clear them before the overflow.

7. RECALIBRATION

Should it be necessary to recalibrate the COPS 80, then act in the following way: enter PROGRAMMING at level #3; put par.**22** to zero; check that par.**23**,**24**,**25** are correct. By means of an accurate current source, suitably connected to the controller input, give the current programmed in par.**23** (0 or 4mA).
Point par.**49**, operate keys [4]+[5] until the display indication matches the correct value (par.**24**).
Now increase the current to 20mA and point par.**50**, always by means of keys [4]+[5] match the displayed pressure with the one programmed in par.**25**.
After recalibration, exit from programming.

8. SERIAL COMMUNICATION

The COPS 80 is fitted with RS485 serial port allowing to take part in a data communication network managed by a master PC. The data base puts all measurement and control data on the net. Through par.**17** you program the controller identification number.
For a detailed data organization description and communication protocol details, read the specific documentation.

TECHNICAL DATA

Dimensions	192x96x60 mm
Operating temp.	-10°C ...+50°C
Range	-1.00 ...+9.00 bar
Resolution	0.01 bar
Pressure input	0/4 ... 20 mA
Transmitter supply	8 ... 16Vdc
Auxiliary inputs	110-240Vac; 5 mA
Alarm relay output	SPDT; 5 A 240Vac
Supply voltage	230 Vac, ±10%; 50/60Hz
Consumption	4VA
Protection on front	IP 54

WARRANTY

LAE electronic Srl warrant that their products are free of any defects in workmanship and materials for a period of 1 (one) year from date of production shown on the enclosure. LAE electronic Srl shall only repair or replace those products of which defects are due to LAE electronic Srl and recognised by their technicians. LAE electronic Srl are not liable for damages resulting from malfunctions of the products.
Defects due to exceptional operating conditions, misapplication and/or tampering will void the warranty.
All transport charges for returning the product to the manufacturer, after prior authorisation by LAE electronic Srl, and for the return to the purchaser are always for the account of the purchaser.

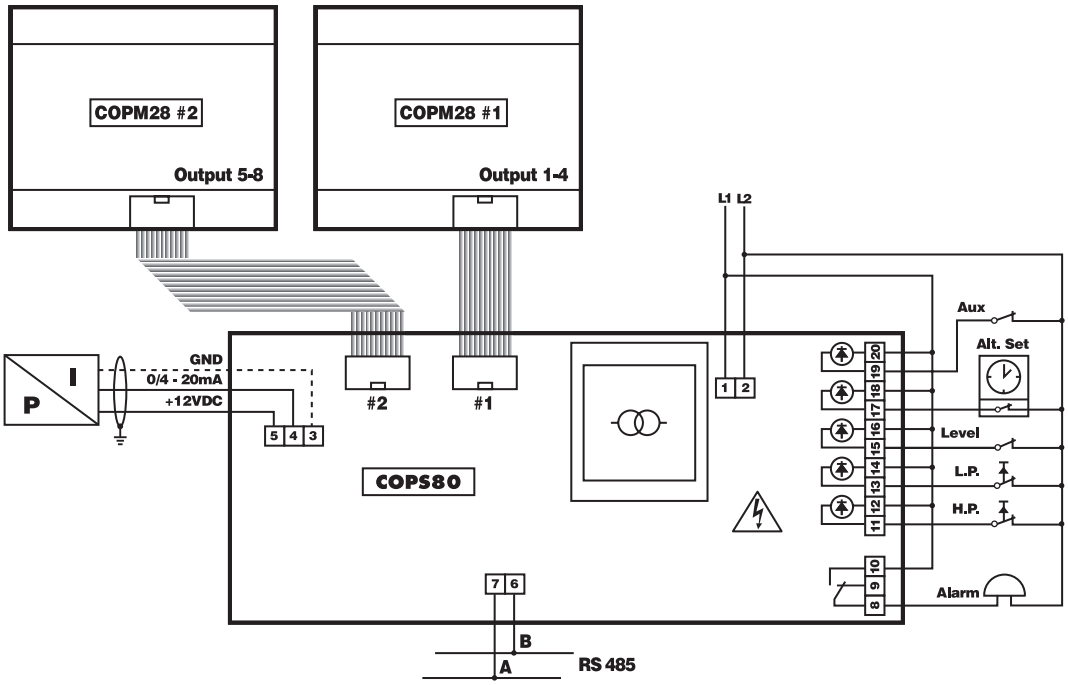


FIGURE 2

1-2	Power supply 230 Vac, 50/60 Hz	11-12	High Pressure switch 110-240 Vac, 50/60 Hz
(3)-4	Pressure transmitter input	13-14	Low Pressure switch 110-240 Vac, 50/60 Hz
5	Transmitter supply +8...+16 Vdc, 25 mA	15-16	Refrigerant Level 110-240 Vac, 50/60 Hz
6-7	RS 485 serial communication port	17-18	Alternative Set 110-240 Vac, 50/60 Hz
8-9-10	Alarm relay 240 Vac, 5 A	19-20	Auxiliary Alarm 110-240 Vac, 50/60 Hz

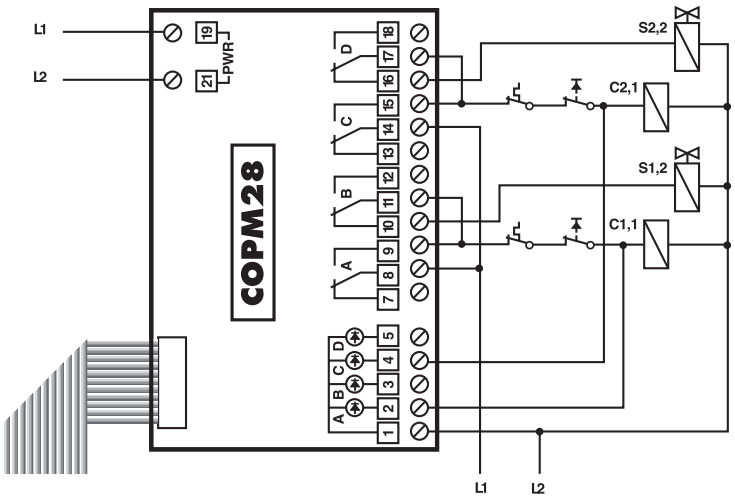


FIGURE 3

C1,1	compressor 1 contactor coil	C2,1	compressor 2 contactor coil
S1,2	compressor 1 second stage solenoid	S2,2	compressor 2 second stage solenoid

TABLE A				
Par.N	**Identification**	**Minimum and Maximum Limits**	**Factory Setting**	**Current Value**
1	**pass code**	0 ... 255	0	____
2	**stand-by**	YES / NO	YES	____
3	**(language)**	Italiano... Español	English	
4	**LCD contrast**	00 ... 100	50	
LEVEL #1, accessible with pass code 24				
5	**main SET**	min.range ... ... max.range	+3.00 b	
6	**alternative SET**	min.range ... ... max.range	+3.50 b	
7	**dead zone**	0.0 ... 2.00 bar	0.20 b	
8	**HP. alarm delay**	0 ... 300 minutes	5 min	
9	**compr.cut-in dly**	0 ... 240 seconds	10 sec	
10	**compr.stop dly**	0 ... 240 seconds	10 sec	
11	**min.compr.stop**	0 ... 20 minutes	3 min	
12	**max.compr.run**	0 ... 120 minutes	60 min	
13	**stage cut-in dly**	0 ... 240 seconds	5 sec	
14	**stage stop dly**	0 ... 240 seconds	5 sec	
15	**warming-up**	0 ... 120 minutes	0 min	
16	**scaling limit.**	0 ... 8	0	
17	**peripheral No.**	1 ... 255	1	
LEVEL #2, accessible with pass code 69				
18	**No. compressors**	1 ... 8(?)	4	
19	**No. stage/compr.**	1 ... 8(?)	1	
20	**compr.rotation**	YES / NO	YES	
21	**refrigerant**	R22, R134A, R404A-507	R134A	
22	**probe offset**	-1.00 ... +1.00	0.00 bar	
23	**min.probe input**	0 ... 5 mA	4 mA	
24	**min.range**	-1.00 ... +1.00 bar	-0.7 b	
25	**max.range**	+1.00 ... +9.00 bar	+8.00 b	
26	**altern.SET input**	YES / NO	NO	
27	**out 1 diagn.**	YES / NO	NO	
LEVEL #2, (continues)				
28	**out 2 diagn.**	YES / NO	NO	
29	**out 3 diagn.**	YES / NO	NO	
30	**out 4 diagn.**	YES / NO	NO	
31	**out 5 diagn.**	YES / NO	NO	
32	**out 6 diagn.**	YES / NO	NO	
33	**out 7 diagn.**	YES / NO	NO	
34	**out 8 diagn.**	YES / NO	NO	
35	**HP press.input**	YES / NO	NO	
36	**LP press.input**	YES / NO	NO	
37	**lqd.level input**	YES / NO	NO	
38	**auxil. input**	YES / NO	NO	
39	**lqd.level delay**	0 ... 120 minutes	10 min	
LEVEL #3, accessible with pass code 104				
40	**next mainten.**	500 ... 30'000 hours	1000 hrs	
41	**out 1 run time**	0 ... 50 hours	0	
42	**out 2 run time**	0 ... 50 hours	0	

43	**out 3 run time**	0 ... 50 hours	0	
44	**out 4 run time**	0 ... 50 hours	0	
45	**out 5 run time**	0 ... 50 hours	0	
46	**out 6 run time**	0 ... 50 hours	0	
47	**out 7 run time**	0 ... 50 hours	0	
48	**out 8 run time**	0 ... 50 hours	0	
49	**0 adjust**	Current pressure	—	
50	**full scale adj.**	Current pressure	—	

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